IN THE MATTER OF
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UNDER SERIAL NO. 12464/2003

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THAT I AM CONVERSANT WITH BOTH THE KOREAN AND THE ENGLISH LANGUAGES : AND

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IN THE NAME OF: LG Philips LCD Co., Ltd.

FOR: APPARATUS FOR FORMING ALIGNMENT FILM OF LIQUID CRYSTAL DISPLAY DEVICE AND METHOD FOR FORMING ALIGNMENT FILM USING THE SAME

IN WITNESS WHEREOF, I SET MY HAND HERETO

THIS 5TH DAY OF February, 2008

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[Translation]

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This application is hereby filed pursuant to Article 42 of the Patent Law.

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[Translation]

APPARATUS FOR FORMING ALIGNMENT FILM OF LIQUID CRYSTAL DISPLAY DEVICE AND METHOD FOR FORMING ALIGNMENT FILM USING THE SAME

[Abstract]

A method for forming an alignment layer of a liquid crystal display device includes providing a substrate with a plurality of unit panels formed thereon, loading the substrate on a stage, selectively dropping an alignment material to a unit panel region by means of an alignment material dropping unit having a plurality of heads having a plurality of holes arranged in a row at regular intervals d1, and forming an alignment layer with a prescribed thickness on the substrate.

[Representative drawing]

Figure 5a

[SPECIFICATION]

[Title of the Invention]

APPARATUS FOR FORMING ALIGNMENT FILM OF LIQUID CRYSTAL DISPLAY DEVICE AND METHOD FOR FORMING ALIGNMENT FILM USING THE SAME

[Brief description of the Drawings]

FIG. 1 is a sectional view showing a general liquid crystal display device;

FIG. 2 is a flow chart of a method for fabricating a liquid crystal display device;

FIG. 3 is a schematic view of a method for forming an alignment layer using a roller coating method according to the related art.

FIG. 4A is a plane view showing a method for forming an alignment layer of a liquid crystal display device in accordance with a first embodiment of the present invention;

FIG. 4B is a sectional view showing the method for forming an alignment layer of a liquid crystal display device in accordance with the first embodiment of the present invention;

FIG. 5 illustrates the bottom surface of an alignment material dropping unit;

FIG. 6 illustrates a defective thickness of an alignment layer;

FIGs. 7 to 9 illustrate a second embodiment of the present invention; and

FIG. 10 illustrates a third embodiment of the present invention.

**** Explanation for the major reference numerals ****

100 : mother substrate 110 : thin film transistor array/color filter substrate

120 : alignment material dropping unit

120a : head 125,225 : hole

130 : alignment layer

[Detailed description of the invention]

[Object of the invention]

[Field of the invention and background art]

The present invention relates to a method for fabricating a liquid crystal display device and, more particularly, to an apparatus for forming an alignment layer of a liquid crystal display device and method for forming an alignment layer using the same.

Recently, with the development of various portable electronic devices such as mobile phones, PDAs and notebook computers, demands for a light, thin, small flat panel display device are increasing. Researches are actively ongoing for the flat panel display devices including an LCD (Liquid Crystal Display), a PDP (Plasma Display Panel), an FED (Field Emission Display), a VFD (Vacuum Fluorescent Display) or the like. Of them, the LCD receives much attention thanks to its simple mass-production technique, easy driving system and implementation of a high picture quality.

FIG. 1 is a schematic view showing a section of a general liquid crystal display device.

As shown in FIG. 1, a liquid crystal display device 1 includes a lower substrate 5, an upper substrate 3 and a liquid crystal layer 7 formed between the lower substrate 5 and the upper substrate 3.

The lower substrate 5 is a driving unit array substrate including a plurality of pixels (not shown). Each pixel includes a driving unit such as a thin film transistor.

The upper substrate 3 is a color filter substrate including a color filter layer for implementing a color.

A pixel electrode and a common electrode are respectively formed on the lower substrate 5 and the upper substrate 3, and an alignment layer for aligning liquid crystal molecules of the liquid crystal layer 7 is formed on the pixel electrode and on the common electrode.

The lower substrate 5 and the upper substrate 3 are attached by a sealing material 9, and the liquid crystal layer 7 is formed therebetween. The liquid crystal molecules of the liquid crystal layer are driven by a driving unit formed at the lower substrate 5 and the quantity of light transmitting the liquid crystal layer is controlled to thereby display information.

The fabrication process of the liquid crystal display device is roughly divided into a driving unit array substrate process for forming a driving unit at the lower substrate 5, a color filter substrate process for forming the color filter at the upper substrate 3, and a cell process.

FIG. 2 is a flow chart of a method for fabricating a liquid crystal display device according to the related art.

In FIG. 2, a step S101 includes forming a plurality of gate lines and a plurality of data lines on the lower substrate 5 using the driving device array process for defining a plurality of pixel areas, and includes formation of thin film transistors, driving devices which are connected to the gate lines and the data lines at the pixel areas. In addition the pixel electrode, which is connected to the thin film transistor through the driving device array process, is formed for driving a liquid crystal layer as a signal is transmitted through the thin film transistor.

A step S104 includes formation of a color filter layer of R, G and B colors and a common electrode on the upper substrate using the color filter process.

Steps S102 and S105 both include formation of alignment layers on the upper and

lower substrates, wherein the alignment layers are rubbed in order to provide the liquid crystal molecules of the liquid crystal layer formed between the upper and lower substrates with an initial alignment and surface fixing force (i.e., pre-tilt angle and orientation direction).

A step S103 includes scattering a plurality of spacers onto the lower substrate for maintaining a uniform cell gap between the upper and lower substrates.

A step S106 includes formation of a sealing material along an outer portion of the upper substrate.

A step S107 includes attaching the upper and lower substrates by compressing the upper and lower substrates together.

A step S108 includes dividing the attached upper and lower substrates into a plurality of individual liquid crystal panels.

A step S109 includes injection of the liquid crystal material into the liquid crystal panels through a liquid crystal injection hole, wherein the liquid crystal injection hole is sealed to form the liquid crystal layer.

A step S110 includes testing the injected liquid crystal panel.

Operation of the LCD device makes use of an electro-optical effect of the liquid crystal material, wherein anisotropy of the liquid crystal material aligns liquid crystal molecules along a specific direction. Accordingly, control of the liquid crystal molecules significantly affects image stabilization of the LCD device. Thus, formation of the alignment layer is critical for fabricating an LCD device that produces quality images.

FIG. 3 is a schematic view of a method for forming an alignment layer using a roller coating method according to the related art. In FIG. 3, an alignment material 21 is uniformly supplied between an anylox roll 22 and a doctor roll 23 of cylindrical shape as the anylox roll 22 and the doctor roll 23 rotate. The alignment material 21 is provided

using a dispenser 20 having an injector shape. Then, the alignment material 21 formed on a surface of the anylox roll 22 is transferred onto a rubber plate 25 when the anylox roll 22 rotates to contact a printing roll 24 upon which the rubber plate 25 is attached. The rubber plate 25 is aligned with a substrate 26 upon which the alignment material 21 will be applied, and a mask pattern is formed on the rubber plate 25 in order to selectively print the alignment layer on the substrate 26.

As a printing table 27, upon which the substrate 26 is loaded, is moved to contact the printing roll 24, the alignment material 21 is transferred onto the rubber plate 25 and is re-transferred onto the substrate 26 to form an alignment layer. Since a thickness of the alignment layer is about 500~1000Å, thickness differences of 100Å of the alignment layer may generate a blot on the screen of the LCD device. Accordingly, uniform thickness of the alignment layer is critical to display quality images on the screen of the LCD device.

However, since the dispenser 20 supplies the alignment material 21 onto the anylox roll 22 using a left-to-right motion along an upper part of the anylox roll 22, uniform thickness of the resulting alignment layer may not be achieved.

For example, as a size of the substrate 26 increases, it becomes increasingly more different to form the alignment layer having a uniform thickness.

Moreover, since all of the alignment material 21 transferred on the rubber plate 25 is not necessarily perfectly re-transferred onto the substrate 26, a significant amount of the alignment material 21 is wasted as compared to the amount of alignment material 21 that is re-transferred onto the substrate 26. Accordingly, the amount of wasted alignment material 21 unnecessarily increases production costs.

In addition, when a model changes according to the size of the substrate, the roll (doctor roll, anylox roll, printing roll) must be replaced accordingly, and since a cleaning process is periodically performed, the process is complicate and its productivity

deteriorates.

Furthermore, as the substrate is enlarged in size, the size of the roll printing device (i.e., the anylox roll and the printing roll) is inevitably increased. That is, the large substrate needs the corresponding large equipment, and in this case, it is difficult to maintain a uniform thickness of the alignment layer.

[Problem to be solved by the invention]

Accordingly, the present invention is directed to an apparatus and method that substantially obviates one or more of the problems due to limitations and disadvantages of the related art.

One object of the present invention is to provide an apparatus for forming an alignment layer of a liquid crystal display device capable of forming an alignment layer with a uniform thickness across an entire surface of a substrate and reducing material waste by coating a necessary amount of alignment material at a desired portion according to an ink-jet method, and a method for forming an alignment layer by using the alignment layer forming apparatus.

Another object of the present invention is to provide a method for forming an alignment layer of a liquid crystal display device capable of obtaining uniformity for the thickness of an alignment layer formed on a substrate and easily coping with multi-model glass on which different sizes of liquid crystal cells are formed by forming the alignment layer on the substrate by shifting an alignment material dropping unit to reduce a distance between alignment materials dropped on the substrate.

[Construction of the invention]

To achieve these and other advantages and in accordance with the purpose of

the present invention, as embodied and broadly described, a method for forming an alignment layer of a liquid crystal display device includes providing a substrate with a plurality of unit panels formed thereon, loading the substrate on a stage, selectively dropping an alignment material to a unit panel region by means of an alignment material dropping unit having a plurality of heads having a plurality of holes arranged in a row at regular intervals d1, and forming an alignment layer with a prescribed thickness on the substrate.

In another aspect, an apparatus for forming an alignment layer of a liquid crystal display device includes an alignment material dropping unit having a plurality of holes arranged in a zigzag form and dropping an alignment material on a substrate, an alignment material supply unit for supplying the alignment material to the alignment material dropping unit, and a connection line unit for connecting the alignment material dropping unit and the alignment material supply unit.

Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings.

FIG. 4 illustrates a method for forming an alignment layer of a liquid crystal display device in accordance with a first embodiment of the present invention, of which FIG. 4A is a plane view showing an apparatus for forming an alignment layer for supplying an alignment material on a substrate and FIG. 4B is a sectional view taken along line I-I' of FIG. 4A.

As illustrated, an alignment layer forming apparatus in accordance with the present invention includes an alignment material dropping unit 120 for dropping an alignment material on a substrate 100 and a stage (not shown) for loading the substrate 100 thereon. After the substrate 100 is provided, the substrate 100 is loaded on the stage, on which an alignment layer is formed.

The substrate 100 is a mother glass on which a plurality of unit panels are formed such as the thin film transistor array substrate or the color filter substrate 110 through the thin film transistor array process and the color filter process.

In the thin film transistor array process, a first transparent substrate is provided, a plurality of gate lines and a plurality of data lines defining pixel area are formed vertically and horizontally on the substrate, a thin film transistor, a driving device connected to the gate line and the data line is formed at each pixel area, a passivation layer is formed at the entire surface of the thin film transistor and the pixel area, and then, a transparent pixel electrode is formed thereon.

In the color filter process, a second transparent substrate is provided, on which a black matrix is formed, a color filter is formed at an area corresponding to the pixel area, on which a common electrode is formed.

Thereafter, an alignment layer is formed on the resulting structure of the substrate 100 by using the alignment forming apparatus. The alignment layer forming apparatus employs an ink-jet method and includes an alignment material dropping unit 120 for directly dropping an alignment material on the substrate 100, an alignment material supply unit (not shown) for supplying an alignment material to the alignment material dropping unit 120, and a connection line unit (not shown) for mechanically connecting the alignment material dropping unit 120 and the alignment material supply unit.

The alignment material dropping unit 120 includes at least one head 120a, and each head 120a includes a plurality of holes. A supply amount of the alignment material to be dropped on the substrate and a dropping position of the alignment material are controlled by opening and closing the holes. In addition, an alignment layer process time can be controlled by controlling the number of holes.

When a nitrogen gas (N2) is supplied to the alignment material supply unit storing

the alignment material, a pressure in the alignment material supply unit is increased due to the nitrogen gas, and accordingly, the alignment material is introduced into the alignment material dropping unit 120 through the connection line unit. At this time, the introduced alignment material is dropped on the substrate 100 through the holes formed at the alignment material-dropping unit 120, forming an alignment layer with a uniform thickness on the substrate 100.

Formation of the alignment layer is made according to movement of the stage on which the substrate is positioned or according to movement of the alignment material dropping unit 120, and an alignment layer 130 is formed on a region of the mother substrate 100 where the alignment material dropping unit 120 has passed. In this case, the alignment layer 130 can be selectively formed by closing some holes formed at the alignment material dropping unit 120 when the alignment material dropping 120 is moved over the stage (not shown) to supply the alignment material 130a on the substrate 100. The alignment layer-formed area is substantially the area where the thin film transistor array and the color filter substrate have been formed.

Since the alignment material dropping unit 120 includes at least one head 120a having the plurality of holes with which it can control the alignment material dropping area according to the size of the mother substrate 100, it can easily cope with a large substrate by increasing the number of heads.

FIG. 5 illustrates the bottom of the alignment material dropping unit 120.

As shown in FIG. 5, the alignment material dropping unit 120 includes the plurality of heads 120a arranged in a row. Each head 120a includes a plurality of holes 125 isolated at regular intervals d1, and the alignment material is dropped on the substrate through the holes 125. Accordingly, by changing the size of the hole 125 and the isolation interval d1 between holes 125, the thickness of the alignment layer and uniformity of the

thickness of the alignment layer formed on the substrate can be controlled.

In addition, since each hole 125 can be opened and closed, even for a multi-model glass having two or more substrate models, the alignment layer can be easily formed by selectively opening and closing the holes.

As mentioned above, the alignment layer forming apparatus using the ink-jet method can easily cope with the various substrate models and a large substrate, and since the necessary amount of alignment material can be dropped directly on the substrate, consumption of the alignment material can be minimized and thus a fabrication cost of the liquid crystal display device can be considerably reduced.

Referring to the interval d1, the narrower the interval d1, the more uniform the thickness of the alignment layer can be formed. In this respect, however, since the hole 125 has a certain size, there is a limitation to narrow the interval d1.

In the meanwhile, since the alignment layer is formed by the uni-directional movement of the stage or the alignment material dropping unit 120, if the interval d1 between holes 125 is wide, as shown in FIG. 6, the alignment layer formed at the area where the alignment material is dropped is thicker than other areas. Thus, the uneven thickness of the alignment layer generates a stain on the screen of the LCD device.

In order to avoid such a problem, in a second embodiment of the present invention, instead of reducing the interval d1, the stage on which the substrate is positioned or the alignment material dropping unit is bi-directonally reciprocated or shifted to thereby reduce the isolation distance of alignment materials dropped on the substrate and thus enhance uniformity of the thickness of the alignment layer.

FIG. 7 illustrates the second embodiment of the present invention directed to improving more the uniformity of the thickness of the alignment layer through a reciprocal movement of the stage or the alignment material dropping unit 120. The same reference

numerals are given to the same elements as those in FIG. 4.

In the second embodiment of the present invention, the alignment layer 130 is formed according to a reciprocal movement of the stage (not shown0 or the alignment material dropping unit 120.

Specifically, after a substrate is loaded on the stage, the alignment material dropping unit 120 is positioned at one side of the stage, and then, an alignment material is dropped on the substrate through the reciprocal movement of the stage or the alignment material dropping unit 120.

For example, the stage is moved one time, the alignment material dropping unit 120 positioned at one side of the stage is shifted by a prescribed distance (h1) and then move one time in the opposite direction, thereby dropping the alignment material on the substrate two times.

In addition, in a state that the stage is fixed, only the alignment material dropping unit 120 can be reciprocally moved, or the stage and the alignment material dropping unit 120 can be moved respectively one time. In this respect, after one-time movement, the alignment material dropping unit 120 positioned at one side of the stage must be shifted by a prescribed distance.

In detail, first, when a first alignment material is dropped on the substrate 100 according to uni-directional movement of the stage, the alignment material dropping unit 120 is positioned at the opposite side of the initial position due to the movement of the stage. At this time, the alignment material dropping unit 120 is moved in the direction vertical to the direction that the stage has moved so that the positions of holes can be shifted, the stage is moved in the opposite direction to the first direction, and then, a second alignment material is dropped on the substrate 100 on which the first alignment material has been dropped. In this case, the alignment material dropping unit 120 can be

moved instead, and the movement order of the stage and the alignment material dropping unit 120 can be changed to each other.

The shift interval h1 must be smaller than the distance d1 between holes 125, and after the alignment material dropping unit 120 has been shifted, the initial positions of holes and the positions of holes after movement must be on a straight line.

In addition, as shown in FIG. 8, in a state that one end of the alignment material dropping unit 120 is fixed, the other end is inclined by as much as θ, so that the distance d2 between holes when the alignment material is dropped on the substrate 100 can be reduced compared to the distance d1 between the original hole 125 and the actual hole 125. Namely, in the state that one end of the alignment material dropping unit 120 is fixed, when the other end is inclined, the isolation distance d1 between holes 125 is the same but the distance d2 between alignment materials dropped on the substrate through holes 125 is reduced. Thus, without mechanically reducing the interval d1, the distance between alignment materials dropped on the substrate can be reduced to enhance uniformity of the thickness of the alignment layer. At this time, the value θ is determined in the range of $0° < \theta < 90°$.

With reference to FIG. 9, since the alignment material dropping unit 120 includes the plurality of heads 120a, an alignment layer can be formed by partially inclining only an arbitrary head 120a. Namely, in case of a multi-model glass model, preferably, the alignment material dropping distance is to be narrowed if the model is small.

Thus, a corresponding head 120a is partially inclined only in a region where the model is relatively small, the positions of the other heads are fixed, so that a flawless alignment layer can be formed for each model with a different size. In this case, the alignment layer can be formed by reciprocally moving the stage or the alignment material dropping unit 120.

In the second embodiment of the present invention, the alignment material dropping unit can be shifted in a direction perpendicular to the direction that the alignment material is dropped, or in a state that one end of the alignment material dropping unit is fixed, the other end thereof is inclined to form a uniform alignment layer.

However, in this case, the alignment material dropping unit 120 needs to be shifted or moved within a prescribed range, which is inconvenient.

That is, in the case that the alignment material dropping unit is shifted (FIG. 7), the shift distance h1 must be smaller than the distance d1 between holes 125, and in the case that one side of the alignment material dropping unit is inclined (FIG. 8), the tilt angle of the alignment material dropping unit must be within the range that the distance d2 between alignment materials as dropped on the substrate is smaller than the distance d1 between the original holes.

FIG. 10 illustrates a third embodiment of the present invention, showing the bottom of the alignment material dropping unit 120 that can form a uniform alignment layer by reducing an alignment material dropping distance even without shifting the head or reciprocal movement.

As shown in FIG. 10, holes are arranged in zigzags to reduce the distance between alignment materials as discharged. Namely, the interval d1 between holes disposed on a straight line are the same in the upper line and the lower line, but since the holes of the upper line and the holes of the lower line are arranged in zigzags, a distance d3 between adjacent alignment materials discharged through the holes is reduced compared to the distance d1. Accordingly, like the former embodiments, a uniform alignment layer can be formed by reducing the alignment material dropping distance.

As mentioned above, the present invention provides the apparatus for forming an alignment layer of a liquid crystal display device and method for forming an alignment

layer using the apparatus, in which, especially, an alignment layer is formed through the ink-jet method and a uniform alignment layer is effectively formed by reducing the distance between holes of the alignment material dropping unit.

A uniform alignment layer is formed by using the alignment layer forming apparatus having the head with a plurality of holes. The alignment layer forming method can cope with a large substrate by controlling the number of heads, and since the alignment layer forming process is simple compared to the conventional art, fabrication efficiency can be enhanced. That is, in the conventional art, since the alignment layer is formed by using the roll printing method, the alignment material is much wasted, and as the substrate is enlarged, it is difficult to form a uniform alignment layer across the entire surface of the substrate. Comparatively, however, in the present invention, since the necessary amount of alignment material can be dropped at the region where an alignment layer is to be formed, the alignment material is not wasted, the fabrication cost can be reduced, and the uniform alignment layer can be formed on a large substrate.

In addition, by shifting the alignment material dropping unit or by arranging the holes in zigzags, the distance between alignment materials dropped on the substrate can be reduced, and thus, a uniform alignment layer can be formed across the entire surface of the substrate.

[Effect of the invention]

As so far described, the apparatus for forming an alignment layer of a liquid crystal display device and method for forming an alignment layer using the apparatus in accordance with the present invention have many advantages.

That is, for example, because an alignment layer is formed by using the ink-jet method, a material cost can be reduced and a process can be simplified. Thus, production

efficiency can be improved. Especially, because an alignment material is dropped by shifting the alignment material dropping unit at a certain angle, the isolation distance between alignment materials dropped on the substrate can be reduced and thus a uniform alignment layer can be formed.

What is claimed is:

1. A method for fabricating a liquid crystal display device comprising:

providing a substrate with a plurality of thin film transistors or color filters thereon; and

selectively dropping an alignment material to a unit panel region by means of an alignment material dropping unit having a plurality of holes to form an alignment layer with a prescribed thickness on the substrate.

2. The method of claim 1, wherein the alignment material dropping unit is shifted in predetermined angle with respect to surface of the substrate when dropping the alignment material.

3. The method of claim 1, wherein the alignment material is dropped when the alignment material dropping unit is moving.

4. The method of claim 1, wherein the alignment material is dropped when the substrate is moving.

5. A method for fabricating a liquid crystal display device comprising:

providing upper and lower mother substrates having a plurality of color filters and thin film transistor arrays and positioning on a stage thereof;

positioning an alignment material dropping unit having a plurality of holes above the mother substrate;

moving the alignment material dropping unit or stage to drop selectively an alignment material on the substrate; and

moving the alignment material dropping unit at the predetermined distance and then moving the alignment material dropping unit or stage in the opposite direction to drop selectively an alignment material on the substrate to form an alignment layer.

6. The method of claim 1, wherein the alignment material dropping unit is disposed in parallel to the substrate and titled by a predetermined angle to the stage.

7. An apparatus for forming an alignment layer of a liquid crystal display device comprising:

an alignment material dropping unit for dropping an alignment material on a substrate;

an alignment material supplying unit for supplying an alignment material to the alignment material dropping unit; and

a connection line unit for connecting the alignment material dropping unit and the alignment material supply unit.

8. The apparatus of claim 7, wherein the alignment material dropping unit includes at least one head.

9. The apparatus of claim 7, wherein the head includes a plurality of holes.

10. The apparatus of claim 7, wherein the holes are arranged in zigzag shape.

11. The apparatus of claim 7, wherein the alignment material dropping unit

is disposed in parallel to the substrate and tilted by a certain angle as much as θ in a stage.

12. The apparatus of claim 11, wherein the tilt angle θ of the alignment material dropping unit is in the range of $0° < \theta < 90°$.

13. The apparatus of claim 7, wherein the alignment material dropping unit is disposed in parallel to the substrate and a part of heads of the alignment material dropping unit tilted by a predetermined angle in a stage.